Network Working Group
Request for Comments: 880

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Obsoletes: RFC 840

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OFFICIAL PROTOCOLS

This RFC identifies the documents specifying the official protocols used in the Internet. Annotations identify any revisions or changes planned.

To first order, the official protocols are those in the "Internet Protocol Transition Workbook" (IPTW) dated March 1982. There are several protocols in use that are not in the IPTW. A few of the protocols in the IPTW have been revised. Notably, the mail protocols have been revised and issued as a volume titled "Internet Mail Protocols" dated November 1982. Telnet and the most useful option protocols were issued by the NIC in a booklet entitled "Internet Telnet Protocol and Options" (ITP), dated June 1983. Some protocols have not been revised for many years, these are found in the old "ARPANET Protocol Handbook" (APH) dated January 1978. There is also a volume of protocol related information called the "Internet Protocol Implementers Guide" (IPIG) dated August 1982.

This document is organized as a sketchy outline. The entries are protocols (e.g., Transmission Control Protocol). In each entry there are notes on status, specification, comments, other references, dependencies, and contact.

The status is one of: required, recommended, elective, or experimental.

The specification identifies the protocol defining documents.

The comments describe any differences from the specification or problems with the protocol.

The other references identify documents that comment on or expand on the protocol.

The dependencies indicate what other protocols are called upon by this protocol.

The contact indicates a person who can answer questions about the protocol.

In particular, the status may be:

required

- all hosts must implement the required protocol,

recommended

- all hosts are encouraged to implement the recommended protocol,

elective

- hosts may implement or not the elective protocol,

experimental

- hosts should not implement the experimental protocol unless they are participating in the experiment and have coordinated their use of this protocol with the contact person, and

none

- this is not a protocol.

Overview

Catenet Model ----------

STATUS: None

SPECIFICATION: IEN 48 (in IPTW)

COMMENTS:

Gives an overview of the organization and principles of the Internet.

Could be revised and expanded.

OTHER REFERENCES:

RFC 871 - A Perspective on the ARPANET Reference Model

DEPENDENCIES:

CONTACT: Postel@USC-ISIF

Network Level

Internet Protocol (IP) ----------

STATUS: Required

SPECIFICATION: RFC 791 (in IPTW)

COMMENTS:

This is the universal protocol of the Internet. This datagram protocol provides the universal addressing of hosts in the Internet.

A few minor problems have been noted in this document.

The most serious is a bit of confusion in the route options. The route options have a pointer that indicates which octet of the route is the next to be used. The confusion is between the phrases "the pointer is relative to this option" and "the smallest legal value for the pointer is 4". If you are confused, forget about the relative part, the pointer begins at 4.

Another important point is the alternate reassembly procedure suggested in RFC 815.

Note that ICMP is defined to be an integral part of IP. You have not completed an implementation of IP if it does not include ICMP.

OTHER REFERENCES:

RFC 815 (in IPIG) - IP Datagram Reassembly Algorithms

RFC 814 (in IPIG) - Names, Addresses, Ports, and Routes

RFC 816 (in IPIG) - Fault Isolation and Recovery

RFC 817 (in IPIG) - Modularity and Efficiency in Protocol Implementation

DEPENDENCIES:

CONTACT: Postel@USC-ISIF

Internet Control Message Protocol (ICMP) ----------

STATUS: Required

SPECIFICATION: RFC 792 (in IPTW)

COMMENTS:

The control messages and error reports that go with the Internet Protocol.

A few minor errors in the document have been noted. Suggestions have been made for additional types of redirect message and additional destination unreachable messages.

Note that ICMP is defined to be an integral part of IP. You have not completed an implementation of IP if it does not include ICMP.

OTHER REFERENCES:

DEPENDENCIES: Internet Protocol

CONTACT: Postel@USC-ISIF

Host Level

User Datagram Protocol (UDP) ----------

STATUS: Recommended

SPECIFICATION: RFC 768 (in IPTW)

COMMENTS:

Provides a datagram service to applications. Adds port addressing to the IP services.

The only change noted for the UDP specification is a minor clarification that if in computing the checksum a padding octet is used for the computation it is not transmitted or counted in the length.

OTHER REFERENCES:

DEPENDENCIES: Internet Protocol

CONTACT: Postel@USC-ISIF

Transmission Control Protocol (TCP)

STATUS: Recommended

SPECIFICATION: RFC 793 (in IPTW)

COMMENTS:

Provides reliable end-to-end data stream service.

Many comments and corrections have been received for the TCP specification document. These are primarily document bugs rather than protocol bugs.

Event Processing Section: There are many minor corrections and clarifications needed in this section.

Push: There are still some phrases in the document that give a "record mark" flavor to the push. These should be further clarified. The push is not a record mark.

Listening Servers: Several comments have been received on difficulties with contacting listening servers. There should be some discussion of implementation issues for servers, and some notes on alternative models of system and process organization for servers.

Maximum Segment Size: The maximum segment size option should be generalized and clarified. It can be used to either increase or decrease the maximum segment size from the default. The default should be established more clearly. The default is based on the default maximum Internet Datagram size which is 576 octets counting the IP and TCP headers. The option counts only the segment data. For each of IP and TCP the minimum header is 20 octets and the maximum header is 60 octets. So the default maximum data segment is could be anywhere from 456 to 536 octets. The current proposal is to set it at 536 data octets.

Idle Connections: There have been questions about automatically closing idle connections. Idle connections are ok, and should not be closed. There are several cases where idle connections arise, for example, in Telnet when a user is thinking for a long time following a message from the server computer before his next input. There is no TCP "probe" mechanism, and none is needed.

Queued Receive Data on Closing: There are several points where it is not clear from the description what to do about data

received by the TCP but not yet passed to the user, particularly when the connection is being closed. In general, the data is to be kept to give to the user if he does a RECV call.

Out of Order Segments: The description says that segments that arrive out of order, that is, are not exactly the next segment to be processed, may be kept on hand. It should also point out that there is a very large performance penalty for not doing so.

User Time Out: This is the time out started on an open or send call. If this user time out occurs the user should be notified, but the connection should not be closed or the TCB deleted. The user should explicitly ABORT the connection if he wants to give up.

OTHER REFERENCES:

RFC 813 (in IPIG) - Window and Acknowledgement Strategy in TCP

RFC 814 (in IPIG) - Names, Addresses, Ports, and Routes

RFC 816 (in IPIG) - Fault Isolation and Recovery

RFC 817 (in IPIG) - Modularity and Efficiency in Protocol Implementation

DEPENDENCIES: Internet Protocol

CONTACT: Postel@USC-ISIF

Host Monitoring Protocol (HMP)

STATUS: Elective

SPECIFICATION: IEN 197

COMMENTS:

This is a good tool for debugging protocol implementations in small remotely located computers.

This protocol is used to monitor Internet gateways and the TACs.

OTHER REFERENCES:

DEPENDENCIES: Internet Protocol

CONTACT: Hinden@BBN-UNIX

Cross Net Debugger (XNET)

STATUS: Elective

SPECIFICATION: IEN 158

COMMENTS:

A debugging protocol, allows debugger like access to remote systems.

This specification should be updated and reissued as an RFC.

OTHER REFERENCES:

RFC 643

DEPENDENCIES: Internet Protocol

CONTACT: Postel@USC-ISIF

Exterior Gateway Protocol (EGP) ----------

STATUS: Experimental

SPECIFICATION: RFC 827

COMMENTS:

The gateway protocol now under development.

Please discuss any plans for implementation or use of this protocol with the contact.

OTHER REFERENCES:

DEPENDENCIES: Internet Protocol

CONTACT: Mills@USC-ISID

Gateway Gateway Protocol (GGP) ----------

STATUS: Experimental

SPECIFICATION: RFC 823

COMMENTS:

The gateway protocol now used in the core gateways.

Please discuss any plans for implementation or use of this protocol with the contact.

OTHER REFERENCES:

DEPENDENCIES: Internet Protocol

CONTACT: Brescia@BBN-UNIX

Multiplexing Protocol (MUX) ----------

STATUS: Experimental

SPECIFICATION: IEN 90

COMMENTS:

Defines a capability to combine several segments from different higher level protocols in one IP datagram.

No current experiment in progress. There is some question as to the extent to which the sharing this protocol envisions can actually take place. Also, there are some issues about the information captured in the multiplexing header being (a) insufficient, or (b) over specific.

Please discuss any plans for implementation or use of this protocol with the contact.

OTHER REFERENCES:

DEPENDENCIES: Internet Protocol

CONTACT: Postel@USC-ISIF

Stream Protocol (ST) ----------

STATUS: Experimental

SPECIFICATION: IEN 119

COMMENTS:

A gateway resource allocation protocol designed for use in multihost real time applications.

The implementation of this protocol has evolved and may no longer be consistent with this specification. The document should be updated and issued as an RFC.

Please discuss any plans for implementation or use of this protocol with the contact.

OTHER REFERENCES:

DEPENDENCIES: Internet Protocol

CONTACT: Forgie@BBN

Network Voice Protocol (NVP-II) ----------

STATUS: Experimental

SPECIFICATION: RFC xxx

COMMENTS:

Defines the procedures for real time voice conferencing.

The specification is an ISI Internal Memo which should be updated and issued as an RFC.

Please discuss any plans for implementation or use of this protocol with the contact.

OTHER REFERENCES:

DEPENDENCIES: Internet Protocol, Stream Protocol

CONTACT: Casner@USC-ISIB

Application Level

Telnet Protocol (TELNET) ----------

STATUS: Recommended

SPECIFICATION: RFC 854 (in "Internet Telnet Protocol and Options")

COMMENTS:

The protocol for remote terminal access.

This has been revised since the IPTW. RFC 764 in IPTW is now obsolete.

OTHER REFERENCES:

DEPENDENCIES: Transmission Control Protocol

CONTACT: Postel@USC-ISIF

Telnet Options (TELNET-OPTIONS)

STATUS: Elective

SPECIFICATION: General description of options: RFC 855
(in "Internet Telnet Protocol and Options")

Number	Name	RFC	NIC	ITP	APH	USE
0	Binary Transmission	856	-----	yes	obs	yes
1	Echo	857	-----	yes	obs	yes
2	Reconnection	...	15391	no	yes	no
3	Suppress Go Ahead	858	-----	yes	obs	yes
4	Approx Message Size Negotiation	...	15393	no	yes	no
5	Status	859	-----	yes	obs	yes
6	Timing Mark	860	-----	yes	obs	yes
7	Remote Controlled Trans and Echo	726	39237	no	yes	no
8	Output Line Width	...	20196	no	yes	no
9	Output Page Size	...	20197	no	yes	no
10	Output Carriage-Return Disposition	652	31155	no	yes	no
11	Output Horizontal Tabstops	653	31156	no	yes	no
12	Output Horizontal Tab Disposition	654	31157	no	yes	no
13	Output Formfeed Disposition	655	31158	no	yes	no
14	Output Vertical Tabstops	656	31159	no	yes	no
15	Output Vertical Tab Disposition	657	31160	no	yes	no
16	Output Linefeed Disposition	658	31161	no	yes	no
17	Extended ASCII	698	32964	no	yes	no
18	Logout	727	40025	no	yes	no
19	Byte Macro	735	42083	no	yes	no
20	Data Entry Terminal	732	41762	no	yes	no
21	SUPDUP	734 736	42213	no	yes	no
22	SUPDUP Output	749	45449	no	no	no
23	Send Location	779	-----	no	no	no
255	Extended-Options-List	861	-----	yes	obs	yes

(obs = obsolete)

The ITP column indicates if the specification is included in the Internet Telnet Protocol and Options. The APH column indicates if the specification is included in the ARPANET Protocol Handbook. The USE column of the table above indicates which options are in general use.

COMMENTS:

The Binary Transmission, Echo, Suppress Go Ahead, Status, Timing Mark, and Extended Options List options have been recently updated and reissued. These are the most frequently implemented options.

The remaining options should be reviewed and the useful ones should be revised and reissued. The others should be eliminated.

The following are recommended: Binary Transmission, Echo, Suppress Go Ahead, Status, Timing Mark, and Extended Options List.

OTHER REFERENCES:

DEPENDENCIES: Telnet

CONTACT: Postel@USC-ISIF

File Transfer Protocol (FTP) ----------

STATUS: Recommended

SPECIFICATION: RFC 765 (in IPTW)

COMMENTS:

The protocol for moving files between Internet hosts. Provides for access control and negotiation of file parameters.

There are a number of minor corrections to be made. A major change is the deletion of the mail commands, and a major clarification is needed in the discussion of the management of the data connection. Also, a suggestion has been made to include some directory manipulation commands (RFC 775).

Even though the MAIL features are defined in this document, they are not to be used. The SMTP protocol is to be used for all mail service in the Internet.

Data Connection Management:

a. Default Data Connection Ports: All FTP implementations must support use of the default data connection ports, and only the User-PI may initiate the use of non-default ports.

b. Negotiating Non-Default Data Ports: The User-PI may specify a non-default user side data port with the PORT command. The User-PI may request the server side to identify a non-default server side data port with the PASV command. Since a connection is defined by the pair of addresses, either of these actions is enough to get a different data connection, still it is permitted to do both

commands to use new ports on both ends of the data connection.

c. Reuse of the Data Connection: When using the stream mode of data transfer the end of the file must be indicated by closing the connection. This causes a problem if multiple files are to be transfered in the session, due to need for TCP to hold the connection record for a time out period to guarantee the reliable communication. Thus the connection can not be reopened at once.

There are two solutions to this problem. The first is to negotiate a non-default port (as in (b) above). The second is to use another transfer mode.

A comment on transfer modes. The stream transfer mode is inherently unreliable, since one can not determine if the connection closed prematurely or not. The other transfer modes (Block, Compressed) do not close the connection to indicate the end of file. They have enough FTP encoding that the data connection can be parsed to determine the end of the file. Thus using these modes one can leave the data connection open for multiple file transfers.

Why this was not a problem with the old NCP FTP:

The NCP was designed with only the ARPANET in mind. The ARPANET provides very reliable service, and the NCP counted on it. If any packet of data from an NCP connection were lost or damaged by the network the NCP could not recover. It is a tribute to the ARPANET designers that the NCP FTP worked so well.

The TCP is designed to provide reliable connections over many different types of networks and interconnections of networks. TCP must cope with a set of networks that can not promise to work as well as the ARPANET. TCP must make its own provisions for end-to-end recovery from lost or damaged packets. This leads to the need for the connection phase-down time-out. The NCP never had to deal with acknowledgements or retransmissions or many other things the TCP must do to make connection reliable in a more complex world.

LIST and NLST:

There is some confusion about the LIST an NLST commands, and what is appropriate to return. Some clarification and

motivation for these commands should be added to the specification.

OTHER REFERENCES:

RFC 678 - Document File Format Standards

DEPENDENCIES: Transmission Control Protocol

CONTACT: Postel@USC-ISIF

Trivial File Transfer Protocol (TFTP) ----------

STATUS: Elective

SPECIFICATION: RFC 783 (in IPTW)

COMMENTS:

A very simple file moving protocol, no access control is provided.

No known problems with this specification. This is in use in several local networks.

OTHER REFERENCES:

DEPENDENCIES: User Datagram Protocol

CONTACT: Postel@USC-ISIF

Simple Mail Transfer Protocol (SMTP) ----------

STATUS: Recommended

SPECIFICATION: RFC 821 (in "Internet Mail Protocols")

COMMENTS:

The procedure for transmitting computer mail between hosts.

This has been revised since the IPTW, it is in the "Internet Mail Protocols" volume of November 1982. RFC 788 (in IPTW) is obsolete.

There have been many misunderstandings and errors in the early implementations. Some documentation of these problems can be found in the file [ISIF]<SMTP>MAIL.ERRORS.

Some minor differences between RFC 821 and RFC 822 should be resolved.

OTHER REFERENCES:

RFC 822 - Mail Header Format Standards

This has been revised since the IPTW, it is in the "Internet Mail Protocols" volume of November 1982. RFC 733 (in IPTW) is obsolete. Further revision of RFC 822 is needed to correct some minor errors in the details of the specification.

DEPENDENCIES: Transmission Control Protocol

CONTACT: Postel@USC-ISIF

Remote Job Entry (RJE) ----------

STATUS: Elective

SPECIFICATION: RFC 407 (in APH)

COMMENTS:

The general protocol for submitting batch jobs and retrieving the results.

Some changes needed for use with TCP.

No known active implementations.

OTHER REFERENCES:

DEPENDENCIES: File Transfer Protocol
Transmission Control Protocol

CONTACT: Postel@USC-ISIF

Remote Job Service (NETRJS) ----------

STATUS: Elective

SPECIFICATION: RFC 740 (in APH)

COMMENTS:

A special protocol for submitting batch jobs and retrieving the results used with the UCLA IBM OS system.

Please discuss any plans for implementation or use of this protocol with the contact.

Revision in progress.

OTHER REFERENCES:

DEPENDENCIES: Transmission Control Protocol

CONTACT: Braden@USC-ISIA

Remote Telnet Service (RTELNET) ----------

STATUS: Elective

SPECIFICATION: RFC 818

COMMENTS:

Provides special access to user Telnet on a remote system.

OTHER REFERENCES:

DEPENDENCIES: Telnet, Transmission Control Protocol

CONTACT: Postel@USC-ISIF

Graphics Protocol (GRAPHICS) ----------

STATUS: Elective

SPECIFICATION: NIC 24308 (in APH)

COMMENTS:

The protocols for vector graphics.

Very minor changes needed for use with TCP.

No known active implementations.

OTHER REFERENCES:

DEPENDENCIES: Telnet, Transmission Control Protocol

CONTACT: Postel@USC-ISIF

Echo Protocol (ECHO) ----------

STATUS: Recommended

SPECIFICATION: RFC 862

COMMENTS:

Debugging protocol, sends back whatever you send it.

OTHER REFERENCES:

DEPENDENCIES: Transmission Control Protocol
or User Datagram Protocol

CONTACT: Postel@USC-ISIF

Discard Protocol (DISCARD) ----------

STATUS: Elective

SPECIFICATION: RFC 863

COMMENTS:

Debugging protocol, throws away whatever you send it.

OTHER REFERENCES:

DEPENDENCIES: Transmission Control Protocol
or User Datagram Protocol

CONTACT: Postel@USC-ISIF

Character Generator Protocol (CHARGEN) ----------

STATUS: Elective

SPECIFICATION: RFC 864

COMMENTS:

Debugging protocol, sends you ASCII data.

OTHER REFERENCES:

DEPENDENCIES: Transmission Control Protocol
or User Datagram Protocol

CONTACT: Postel@USC-ISIF

Quote of the Day Protocol (QUOTE) ----------

STATUS: Elective

SPECIFICATION: RFC 865

COMMENTS:

Debugging protocol, sends you a short ASCII message.

OTHER REFERENCES:

DEPENDENCIES: Transmission Control Protocol
or User Datagram Protocol

CONTACT: Postel@USC-ISIF

Active Users Protocol (USERS) ----------

STATUS: Elective

SPECIFICATION: RFC 866

COMMENTS:

Lists the currently active users.

OTHER REFERENCES:

DEPENDENCIES: Transmission Control Protocol
or User Datagram Protocol

CONTACT: Postel@USC-ISIF

Finger Protocol (FINGER) ----------

STATUS: Elective

SPECIFICATION: RFC 742 (in APH)

COMMENTS:

Provides information on the current or most recent activity of a user.

Some extensions have been suggested.

Some changes are are needed for TCP.

OTHER REFERENCES:

DEPENDENCIES: Transmission Control Protocol

CONTACT: Postel@USC-ISIF

NICNAME Protocol (NICNAME) ----------

STATUS: Elective

SPECIFICATION: RFC 812 (in IPTW)

COMMENTS:

Accesses the ARPANET Directory database. Provides a way to find out about people, their addresses, phone numbers, organizations, and mailboxes.

OTHER REFERENCES:

DEPENDENCIES: Transmission Control Protocol

CONTACT: Feinler@SRI-NIC

HOSTNAME Protocol (HOSTNAME) ----------

STATUS: Elective

SPECIFICATION: RFC 811 (in IPTW)

COMMENTS:

Accesses the Registered Internet Hosts database (HOSTS.TXT). Provides a way to find out about a host in the Internet, its Internet Address, and the protocols it implements.

OTHER REFERENCES:

RFC 810 - Host Table Specification

DEPENDENCIES: Transmission Control Protocol

CONTACT: Feinler@SRI-NIC

Host Name Server Protocol (NAMESERVER) ----------

STATUS: Experimental

SPECIFICATION: IEN 116 (in IPTW)

COMMENTS:

Provides machine oriented procedure for translating a host name to an Internet Address.

This specification has significant problems: 1) The name syntax is out of date. 2) The protocol details are ambiguous, in particular, the length octet either does or doesn't include itself and the op code. 3) The extensions are not supported by any known implementation.

Work is in progress on a significant revision. Further implementations of this protocol are not advised.

Please discuss any plans for implementation or use of this protocol with the contact.

OTHER REFERENCES:

DEPENDENCIES: User Datagram Protocol

CONTACT: Postel@USC-ISIF

CSNET Mailbox Name Server Protocol (CSNET-NAMESERVER) ----------

STATUS: Experimental

SPECIFICATION: CS-DN-2

COMMENTS:

Provides access to the CSNET data base of users to give information about users names, affiliations, and mailboxes.

Please discuss any plans for implementation or use of this protocol with the contact.

OTHER REFERENCES:

DEPENDENCIES: Transmission Control Protocol

CONTACT: Solomon@UWISC

Daytime Protocol (DAYTIME) ----------

STATUS: Elective

SPECIFICATION: RFC 867

COMMENTS:

Provides the day and time in ASCII character string.

OTHER REFERENCES:

DEPENDENCIES: Transmission Control Protocol
or User Datagram Protocol

CONTACT: Postel@USC-ISIF

Time Server Protocol (TIME) ----------

STATUS: Recommended

SPECIFICATION: RFC 868

COMMENTS:

Provides the time as the number of seconds from a specified reference time.

OTHER REFERENCES:

DEPENDENCIES: Transmission Control Protocol
or User Datagram Protocol

CONTACT: Postel@USC-ISIF

DCNET Time Server Protocol (CLOCK) ----------

STATUS: Elective

SPECIFICATION: RFC 778

COMMENTS:

Provides a mechanism for keeping synchronized clocks.

OTHER REFERENCES:

DEPENDENCIES: Internet Control Message Protocol

CONTACT: Mills@USC-ISID

SUPDUP Protocol (SUPDUP) ----------

STATUS: Elective

SPECIFICATION: RFC 734 (in APH)

COMMENTS:

A special Telnet like protocol for display terminals.

OTHER REFERENCES:

DEPENDENCIES: Transmission Control Protocol

CONTACT: Admin.MRC@SU-SCORE

Internet Message Protocol (MPM) ----------

STATUS: Experimental

SPECIFICATION: RFC 759

COMMENTS:

This is an experimental multimedia mail transfer protocol. The implementation is called a Message Processing Module or MPM.

Please discuss any plans for implementation or use of this protocol with the contact.

OTHER REFERENCES:

RFC 767 - Structured Document Formats

DEPENDENCIES: Transmission Control Protocol

CONTACT: Postel@USC-ISIF

Network Standard Text Editor (NETED) ----------

STATUS: Elective

SPECIFICATION: RFC 569

COMMENTS:

Describes a simple line editor which could be provided by every Internet host.

OTHER REFERENCES:

DEPENDENCIES:

CONTACT: Postel@USC-ISIF

Appendices

Assigned Numbers ----------

STATUS: None

SPECIFICATION: RFC 870

COMMENTS:

Describes the fields of various protocols that are assigned specific values for actual use, and lists the currently assigned values.

Issued October 1983, replaces RFC 790 in IPTW, and RFC 820 of January 1983.

OTHER REFERENCES:

CONTACT: JKReynolds@USC-ISIF

Pre-emption ----------

STATUS: Elective

SPECIFICATION: RFC 794 (in IPTW)

COMMENTS:

Describes how to do pre-emption of TCP connections.

OTHER REFERENCES:

CONTACT: Postel@USC-ISIF

Service Mappings ----------

STATUS: None

SPECIFICATION: RFC 795 (in IPTW)

COMMENTS:

Describes the mapping of the IP type of service field onto the parameters of some specific networks.

Out of date, needs revision.

OTHER REFERENCES:

CONTACT: Postel@USC-ISIF

Address Mappings ----------

STATUS: None

SPECIFICATION: RFC 796 (in IPTW)

COMMENTS:

Describes the mapping between Internet Addresses and the addresses of some specific networks.

Out of date, needs revision.

OTHER REFERENCES:

CONTACT: Postel@USC-ISIF

Internet Protocol on X.25 Networks ----------

STATUS: Recommended

SPECIFICATION: RFC 877

COMMENTS:

Describes a standard for the transmission of IP Datagrams over Public Data Networks.

OTHER REFERENCES:

CONTACT: jtk@PURDUE